Understanding Biofilm-based Wound Care: What You Need To Know

Q&A

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Q: What is the best in vitro methodology for simulating polymicrobial biofilms?

A: The best in vitro method to simulate polymicrobial biofilms is the ‘pig skin’ explant model with an inoculum of multiple bacterial species - P aeruginosa, Staph aureus, and Strep species etc.

Q: When is a biofilm most likely to form?

A: Biofilms can form on any wound when planktonic bacteria are not quickly killed by the patient’s own immune system, or by exogenous antibiotics or antiseptics. Lab studies and clinical studies show that biofilms can reform in two to three days after debridement in a chronic wound.

Q: So, biofilms delay wound closure, not planktonic bacteria? Is this true for all species?

A: If planktonic bacteria reach sufficiently high levels, usually >5 logs CFU for most bacterial species, then wound healing will be impaired. Some planktonic bacteria are more virulent than others because they secrete powerful exotoxins that kill wound cells or impair inflammatory cells.

In most mouse skin wound models, it is hard to infect an acute wound with planktonic bacteria unless you overwhelm the mouse's immune system, which is very effective at killing most planktonic bacteria.
Q: Is it better to intervene at an earlier stage, such as the colonisation stage?

A: Yes, preventing planktonic bacteria from attaching and converting into a protective biofilm phenotype is much more effective than trying to kill/remove a mature biofilm in a wound.

Q: When should we treat *Pseudomonas* isolates from the surface of a chronic wound?

A: Some authors choose to double treat all *Pseudomonas* isolates, both topically and parenterally. However, probably as we currently understand this, we should treat:
1. Wounds that aren't progressing at least 0.5 mm/edge/week
2. Wounds with >10⁵ *Pseudomonas*.

In these cases we will treat for two weeks with:
1. Primary mechanical (sharp debridement)
2. A topical antimicrobial, which has shown to be effective against *Pseudomonas*
3. An oral agent that is effective against that isolate of *Pseudomonas*.

Q: Should we use antimicrobial solutions, like Prontosan® or Dermacyn®, preventively in chronic wounds, or just in the ones that are not healing?

A: In general, we would advocate using antimicrobials only in wounds that appear to be critically colonised, so wounds that have high bioburdens (>10⁵) or are healing at a rate of < 0.5 mm/week.

Q: Is there any data on hyperbaric oxygen in preventing the formation or treating biofilms?

A: There are not yet any published papers that have carefully examined that question, but several research groups are working on getting the answer.

Q: Many clinicians seem to claim that the biofilm is visible as the shiny layer on a chronic wound, BUT many of the chronic wounds I have seen with this ‘shiny’ layer were not delayed in healing. How can we clinically identify biofilms, or do we need specific laboratory tests?

A: Most biofilms on wounds are not visible to the eye because they are microscopic structures. However, if biofilm communities become really large on the surface of a wound, they can be seen. Most of the ‘shiny’ structures on wound beds are actually fibrin slough that is formed in response to biofilms buried deeper in the wound bed.
Q: Where can we see the references for these slides?

A: All references from both presentations are available via the resources link at the top of the page.

Q: Can larvae effect biofilm formation?

A: There are a significant number of publications which demonstrate that maggot secretions inhibit or destroy biofilm demonstration. Interestingly the secretions appear to use different mechanisms for different types of bacteria.

Q: Does $\text{H}_2\text{O}_2$ have any effect on Biofilm?

A: Hydrogen peroxide at concentrations that are recommended for wound irrigation and wound cleansing reduces levels of bacteria (CFU) in mature biofilm 1-2 logs out of 8 logs of bacteria. So, hydrogen peroxide is not very effective against mature biofilms in wounds.

Q: Do you think hypertonic saline dressings may have a role in managing the polysaccharide membrane created by the biofilm? To me it seems like taking away the 'sugar and replace it with a salt'. I personally find this an effective management plan, but do not have any laboratory evidence--everyone seems to be looking at the expensive silver, but not the inexpensive hypertonic salt.

A: My lab has not tested hypertonic salt dressings in our pig skin explant model, so I do not have data to support any conclusions. However, we will test this question!

Q:
1) What debridement techniques can be advised for biofilm removal?
2) Can any other iodine derivatives remove biofilm beyond Cadexomer Iodine?

A: Several physical methods are effective at removing biofilms from wounds, especially sharp debridement with a scalpel and the Versajet™. To our surprise, maggots are VERY effective at removing biofilms in our pig skin explant model of biofilms.

In our in vitro testing, povidone iodine is less effective than Cadexomer Iodine.

Q: What is the correct procedure for using Cadexomer Iodine on wounds?

A: Where necessary, debride the base of the wound. Place the Cadexomer Iodine directly upon the wound, it can be covered by the dressing of your choice and left in place for up to 72 hours. The dressing will become gray (from brown) when all the iodine has been used. The entire base of the gel should be removed and washed out with normal saline.
Q: What is reactive oxygen species - please explain.

A: Reactive oxygen species is the term biochemists use for the hydrogen peroxide (H$_2$O$_2$) and hypochlorous acid (HOCl) that are naturally produced by neutrophils and macrophages.

Q: The biofilm pig skin model only looks at the effects of iodine-related products and silver products. What is your experience with topical antiseptic solutions, when either used as solution with gauze on the model or as impregnated, commercially available gauze?

A: In general, antiseptic solutions used to cleanse wounds that contain PHMB, CHG, dilute iodine, dilute bleach, etc, are minimally effective in killing mature biofilms grown on pig skin explants, reducing biofilm bacteria levels 1 to 2 logs out of 8 logs of total bacteria. Note this is based on in vitro evidence.

Q: Do all labs have the equipment to test for biofilms? How long does it take?

A: Standard clinical microbiology labs do not process wound samples (swabs, biopsies) with the specialised procedures that are required to break up the biofilms (ultrasonic dispersal of biofilm) sufficiently enough to allow growth of the bacteria. However, most clinical microbiology labs could rather easily upgrade their instruments and training to be able to measure biofilms in wound samples.

Q: How would I recognise a biofilm?

A: On clinical grounds:
1. Wounds with a large amount of slough/slime build up despite frequent debridement
2. Wounds that continue to fail to close despite appropriate (non-antimicrobial) therapy
3. Wounds that have secondary signs of non-progression, drainage or foul odour with quantitative cultures > 10$^5$.

Q: Is cleansing with topical antiseptics important in removing biofilms?

A: Repeated debridement is important in removing biofilms and if topical antiseptics are part of that algorithm, or are delivered under pressure or ultrasound agitation, they may facilitate removal of the non-planktonic bacteria.

Q: Why have diabetic foot patients been left out of biofilm studies using Cadexomer Iodine until now?
A: It is unclear, but it probably has been secondary to the hypothesis being studied. Most studies of Cadexomer Iodine have looked at venous leg ulcers. In addition, diabetic foot ulcer studies are costly and difficult to run, and secondary to the chronic medical problems of the diabetic population.

Q: How much time do biofilms delay wound healing when treated with techniques other than Cadexomer Iodine-based products?

A: There is no actual data in regards to this. This would require a study with multiple agents and a large population. A simpler answer is that with any wound which is progressing at less than 0.5 mm/edge/week, one must at least think about biofilms as having a possible role.

Q: Are you aware of any evidence supporting the effect of honey on a biofilm?

A: We tested medicinal honey in our pig skin explant model and it reduced levels of mature biofilm - 1-2 logs out of 8 logs of total biofilm.

Q: What type(s) of secondary dressings was/were applied in the study by Dr John Timmons?

A: Allevyn™ foam (closed cell – non-stick foam) was used in most cases - gauze in a minority.

Q: Is Cadexomer Iodine safe to use in diabetic foot wounds?

A: We had no serious adverse events related to the product in our study. Since the wound is easily inspected we use it clinically as well, with no noted adverse events.

Q: With maintenance debridement, when should you stop?

A: While one can continue debridement as long as the wound is closing at a rate > 0.5 mm/edge/week we usually stop when the wound appears ready for delayed primary closure with another therapy, such as skin analogue, skin graft or growth factor therapy.

Q: Your study shows some dramatic reductions in wound size. Why do you think this is the case?
A: A combination of:
1. Serial debridement
2. Bioburden control
3. Adequate offloading.

Q: How can you tell if you've successfully treated biofilm in a chronic wound?

A: At present since in vivo biofilm assays are difficult to do for most labs, the best clinical sign is appropriate progression of a non-closing wound to a closing wound. On average, in our hands, this appears to be about three weeks. However, we need better in vivo data on this.

Q: How can we prevent the biofilms forming in the first place? Are there risk factors associated with biofilms we should be trying to identify and manage from our nursing assessments?

A: At present all the host characteristics that allow biofilm formation are not clear. There is a significant role in which bacteria plays in the wound, and the bacterial type itself plays a large role. It also appears in some preliminary work that the duration of the wound plays a role in the development of the biofilm. At present while high glycosolated haemoglobins, poor nutrition and such factors have been associated with high infection rates, these have been with planktonic bacteria and not non-planktonic bacteria.

Q: What debridement method was used in Dr Lantis study?

A: Sharp - bedside curette debridement, followed by saline irrigation, at the initial enrolment and in > 80% of subsequent weekly visits.

Q: Are some wounds more likely to develop biofilm than others? Are there exceptions?

A: Bacteria would be more likely to form biofilms on wounds that have ischemia, or in patients that have impaired immune systems, since the planktonic bacteria will be able to attach and convert into biofilms before they are killed.

Q: What is PHMB?

A: PHMB is the acronym for PolyHexaMethylene Biguanide.

Q: What exactly are planktonic bacteria?
A: Planktonic bacteria refer to the single, non-adherent forms of bacteria.

Q: Could a chemical debrider be used before the Cadexomer Iodine? (Rather than sharp methods).
A: Yes, different methods of debridement can be used before Cadexomer Iodine dressings.

Q: Can nanocrystalline silver be used in combination with Cadexomer Iodine to treat and prevent biofilm formation at the same time?
A: There is no reason to use them simultaneously.

Q: How long should the Cadexomer Iodine treatment be used before moving on to other treatment such as silver dressings?
A: Our clinicians typically use Cadexomer Iodine dressings for three to five days before switching to a different type of bacterial barrier dressing, such as a silver-releasing dressing for the next three to five days. The wound is then examined again.

Q: Do you think that shear stress is an important factor in the formation of biofilm in the pig skin explant model? If yes, do you think it is possible to use a flow cell with the pig skin explant?
A: The structure and make-up of the exopolymeric matrix of biofilms is influenced by sheer forces. A flow cell could potentially be designed to use with the pig skin explants.

Q: Are there any differences in the phenotype of biofilms in critically colonised wounds and infected wounds?
A: That is a great question, but I do not know of any good data on this.

Q: The reduction of bioburden by 1 - 2 logs in the H₂O² Q&A is criticised, however Dr Lantis’s study showed only a small mean log reduction of 1 log, and the clinical results appeared positive - why is only one of these modest bioburden reductions considered good?
A: The 90% reduction in bioburden corresponding to a 1 log reduction was enough to drop below the pre-defined 10⁵ bioburden number allowing the wounds to progress.
Q: In a case using Cadexomer Iodine in the form of a dressing, should it be used at the edge of the wound only or should it fill the wound?

A: Fill the wound to approximately 3mm thickness.

Q: When using Cadexomer Iodine, how long do you use it for? At what stage should one stop using it? Does it have any contraindications?

A: In this study we used Cadexomer Iodine for six weeks. However, if we see good progression and improvement of the wound we like to stop the therapy as soon as three weeks, depending upon the size and drainage of the wound. Please consult the manufacturer's instructions for contraindications.

Q: Is Cadexomer Iodine safer to use with thyroid patients?

A: It is contraindicated in patients with iodine sensitive thyroid conditions and such patients were excluded from our study.

Q: Why don’t biofilms form on normal unwounded skin?

A: Normal skin actually does have small amounts of biofilm in some structures, like oil gland ducts, but biofilms are not found in the deep layers of normal epidermis.

Q: How do you control pain during the debridement?

A: In our experience most diabetic foot ulcer patients by definition have very little debridement related pain. No analgesia was needed in this cohort.

Q: Further to the question relating to the dramatic reductions in the size of the wound were there other factors taken into consideration, such as blood glucose levels?

A: Actually, in order to make this more real world we did not disallow for elevated glycosolated haemoglobins. Patients with diminished creatinine clearance were disallowed, and to be clear, the group only included Meggit-Wagner class 1 and 2 ulcers.

Q: Is there a time limit when using Cadomexer Iodine? The healing wounds I see are usually on the large side and I was taught that there was a limit to the amount of iodine one could use per week. Also, should it be used with caution in patients with thyroid problems? What is your view on this?
A: This study was a six-week duration. Clinically we have used it for up to three months in large venous leg ulcers. However, we would not use it on a patient with thyroid or Graves’s disease. Patients with any thyroid pathology were excluded from this trial. The manufacturer's instructions have more information on maximum use.

Q: Does using Dakin’s solution (3rd solution) for cleansing the wound impede the effects of Cadexomer Iodine?

A: Some solutions are not compatible with other products. Please ask the manufacturer about this.

Q: Can Iodosorb™ be used on a one-year old patient?

A: This product has not been studied in children.

Q: What are the effects of vinegar on wounds?

A: Dilute acetic acid (vinegar) may help remove bacteria like *Pseudomonas aeruginosa*, possibly by lowering the pH to levels that impair the growth of those bacteria or by solubilising the denatured collagen in the wound bed to which the bacteria are attached.

Q: A patient with a venous leg ulcer that I saw recently had glandulous yellow slough on their wounds. When the slough was debrided, the depth was very deep and the patient was painful. Do you think it contained biofilm?

A: While this slough almost definitively contains non-planktonic bacteria, it is most likely made up of: fibrin, denatured collagen, matrix metalloproteases, planktonic bacteria and some component of host inflammatory cells.

Q: How do I measure and characterise the biofilm of a wound?

A: Wound biopsies or swabs need to be processed using special techniques to disperse the biofilm community without killing all the bacteria. Standard clinical microbiology labs do not usually have ultrasonic instruments or trained personnel to do the biofilm assay procedures. You can learn about these procedures by reading most research papers that measure biofilms.
Q: Any experience with chelating agents?

A: My lab has tested EDTA solutions with the pig skin explant biofilm model, and when used alone, EDTA has minimal effect on killing biofilms.

Q: Does nutrition affect the formation of a biofilm?

A: Nutrition does not directly influence whether a colonising bacteria will convert into a biofilm phenotype. Quorum molecules synthesised by the bacteria regulate that process.

Q: Biofilms can’t be seen with the naked eye or be distinguished from the slough?

A: Wound slough consists almost entirely of fibrin that originates from the plasma. Biofilms stimulate inflammation which increases the permeability of capillaries and results in more fibrin slough building up on a wound bed.

Most biofilms cannot be seen by the naked eye because they are microscopic structures. However, massive biofilm colonies can give a wound bed a slightly different shiny appearance.

Q: What products on the market work against biofilms?

A: Our in vitro results indicate that potentially the most effective dressing to kill bacteria in mature biofilms is Cadexomer Iodine dressings. Silver dressings, PHMB, and Dakin’s kill 1-2 logs of biofilm in a colony of 8 logs of biofilm.

Q: Can planktonic bacteria be detected in patients before a biofilm forms?

A: Some patients may be carriers of planktonic bacteria that form robust biofilms, but most biofilms spread between patients as planktonic bacteria, not as biofilms.

Q: In an outpatient clinic, how often should a patient come in for a clinician to actively debride their wounds to keep the wound healing progressing?

A: Data would support weekly debridement, which have shown to independently improve healing rates in both diabetic foot ulcers and venous leg ulcers. However, this is an individual issue for each wound and should be assessed by the clinician.

Q: Is there any data available that indicates if medicinal larvae/maggot debridement therapies are effective in removing or preventing biofilm in chronic wounds?
A: Our in vitro data using the pig skin explant biofilm model showed that medical maggots were VERY effective in removing biofilms -- nearly totally removed 8 logs of biofilm.

Q: Have you had any success with Medihoney® for removing biofilm?

A: In the pig skin explant model of mature biofilms, medicinal honey reduced biofilms 1 to 2 logs in a population of 8 logs of biofilm - so it only had a minimal effect.

Q: What is the effect of ultraviolet treatment on the prevention of biofilms?

A: Unfortunately, it has not been studied in biofilms grown on skin explants or on patients.

Q: In the study using ultrasonic cleansing with a bactericidal fluid, what was the fluid used in the study?

A: We tested several fluids in vitro. Saline did not reduce biofilms, but a dilute silver nitrate solution did by 4 logs at six hours after treatment.

Q: Are biofilms responsible for elevated levels of proteases in wounds?

A: Yes, because biofilms are extremely inflammatory and draw neutrophils and macrophages into the wound bed where they secrete proteases, or MMPs and elastase.

Q: Do biofilms cause painful wounds?

A: Pain is not a unique characteristic of biofilms. However, wounds with pain - may or may not have biofilms.

Q: Do biofilms inhibit wound closure, or can wounds close with them present?

A: There is strong evidence that biofilms can/do inhibit wound closure. However, most likely, there are wounds that close with biofilms present. The thing that we need to understand better is the host response to the biofilm.

Q: I would like to know what you suggest using as local treatment for patients with thyroid disease, as iodine should be carefully used.

A: In patients with thyroid disease, we use both nanocrystalline silver and sustained-release silver sulfadiazine products. Instructions for use suggest that Cadexomer Iodine
products are contraindicated for use in thyroid patients and manufacturer’s instructions should always be consulted.

Q: Has your group measure the effectiveness of Inadine®, another sustained release dressing?

A: No, it is not available in the US.

Q: What kind of debridement do you recommend performing?

A: Sharp episodic (weekly) debridement was used in this study, and this is what we would usually advocate as well. It is quick, inexpensive and effective. However, this is an individual issue for each wound and should be assessed by the clinician.

Q: How would I know that a biofilm is present in a wound?

A: Unfortunately, most standard clinical microbiology labs are not trained to measure biofilms in wound samples, so clinicians are left with trying to detect the signs of biofilms. For example, the failure of a wound to progress as expected when the patient is on systemic or topical antibiotics.

Q: We have biopsied (6mm deep) 15 venous leg ulcers and have found that 90% of them had multiple types of bacteria greater than $10^5$ up to 6,000,000. All were sharp debrided under local anaesthesia before biopsies. Our treatment protocol states that we need to administer antibiotics, however this has very limited effect. None of the venous leg ulcers returned to levels below local infection less than $10^5$. To get rid of the biofilm we would have had to cut down much deeper than what we normally could in an outpatient setting. From your studies, how deep do biofilms go?

A: Data from our pig skin explant model and from other labs examining biopsies from chronic wounds indicate that biofilms can penetrate deeply into wound beds, including into the subcutaneous fat and muscle layers to bone. A key concept in biofilm-based wound care is to combine effective debridement with effective bacterial barrier (microbicidal) wound dressings since data showed conclusively that mature biofilms can reform on patients' wounds in two to three days.

Q: How would you treat a patient with an ulcer due to vascular disease, who has severe pain, and when negative pressure wound therapy is not an option?

A: The first thing I would do is to try all the tools I have to revascularise the patient. I would then debride under anaesthesia after revascularising the wound. If the wound
cannot be revascularised I would be willing to try a topical antimicrobial. However, the underlying problem in that patient is unlikely to be improved by bioburden control. One may wish to try a topical debriding agent, as mechanical episodic debridement is not well tolerated in the ischemic patient, in general.

Q: Was there a different between wounds in Dr Timmons’s study, such as neuropathic or presence of PAD?

A: Wounds in our study, had:
1) Adequate perfusion
2) Glycosolated haemoglobin was not a rate-limiting factor
3) All wounds were Meggit class 1-2
4) All wounds were what one would define as a malperforans ulcer.

Q: Can you comment on whether there is any issue with resistance over time with the use of nanocrystalline silver?

A: I do not know of any credible reports that show development of silver resistant bacteria on wounds treated with nanocrystalline silver dressings.

Q: How did Dr. Landis' study measure wound size?

A: Tracing Planimetry/Digital planimetry and ARANZ.

Q: Who is the vender for Cadexomer Iodine?

A: Smith and Nephew distribute Cadexomer Iodine.

Q: Why should future studies include testing for biofilms?

A: Biofilms are a major stimulus for chronic inflammation, which results in elevated levels of proteases and reactive oxygen species in wounds that destroy endogenous proteins that are essential for healing. Controlling biofilms will help to ‘normalise’ patients entering clinical wound care trials.

Q: Is Cadexomer Iodine easy to apply in diabetic foot?

A: Yes, we find a tongue blade to be best.
Q: In your study, what would you have done differently if you had known a wound contained a biofilm?

A: Nothing at this point, based on our clinical knowledge - as we were frequently debriding and placing an agent that has *in vitro* activity against biofilms. That perspective may change as we gain more clinical correlation knowledge.

Q: How long did it take for those with 50% reduction in size to heal?

A: Many of them went on to use secondary agents such as skin substitutes, dermal substitutes or growth factors - so in such a small group the final outcome is too varied to comment on.

Q: How often would you suggest a dressing should be changed to maximise the use of the Cadexomer Iodine in the removal of the biofilm?

A: Our clinicians use the change in the colour of the cadexomer dressing to help decide when to replace the dressing.

Q: Why do you think Cadexomer Iodine is more successful at breaking through the polysaccharide matrix than other antimicrobials?

A: Our data with the pig skin explant model of biofilms indicate the sustained release properties of the Cadexomer Iodine may be a factor that enables it to effectively kill biofilms. The exact mechanism of action is not yet fully defined.

Q: What is the recommended length of treatment time with Cadexomer Iodine? Do the bacteria build up a tolerance? Should you alternate treatments with another antimicrobial?

A: This study was for six weeks, but we use Cadexomer Iodine for up to 12 weeks. The average in our centre is actually three weeks. Due to this being a contact-based antimicrobial we are not aware of any true resistance/tolerance. We do not usually alternate treatments.

Q: In Germany, at the Max Plank Institute, they are testing cold plasma. They have good results in destroying bacteria with cold plasma, would this therapy also destroy biofilms?

A: That is an excellent question that should be answered for the field. I think cold plasma treatment might reduce mature biofilms, but experiments need to be done.
Q: Would superabsorbent dressings, which physically remove slough, not also physically remove biofilm?

A: There hasn’t been adequate testing on superabsorbent dressings, so unfortunately we do not know this.

Q: The study reported on a re-dressing median of eight times per week. Do you have results for dressing two to three times per week?

A: We were surprised by the frequency of dressing changes, which in general reflects the bathing practices of this cohort. We had intended for longer wear times. Therefore, in this population, we do not have adequate data to report.

Q: Are you using the Cadexomer Iodine as a primary dressing in all diabetic foot ulcers?

A: No, only those that we are treating for bacterial burden. Our premise is that antimicrobials are effective in wounds with high bioburdens.

Q: Do you think the sample size is adequate in these studies to come to conclusions?

A: It is sufficient to answer the questions:

1. Was there a correlation between bioburden reduction and wound size reduction?
2. Was there a decrease in in vivo bacterial burdens.

Q: Is there any evidence of the development of microbial resistance to Cadexomer Iodine?

A: I do not know of any data that indicates bacteria can develop resistance to sustained release iodine.

Q: Is debridement done on the callous on the plantar surface during treatment?

A: In our practice, the callus is debrided, but more importantly are the epithelial border and the wound bed. We try to create a 45° bevelled wound bed, encompassing all areas from callus through the centre of the wound. However, treatment modality should depend on the patient, the wound and the clinician’s experience.
Q: While using Cadexomer Iodine, at what wound size should we be concerned about iodine exposure?

A: This study was limited to wounds that were less than 20 sq cm. In general, we don't have experience with using this dressing in wounds larger than that. There is information on exposure in the manufacturer’s instructions for Cadexomer Iodine products.

Q: Since testing for biofilms is limited and difficult to detect by the naked eye, should systemic or topical antibiotics be tried first before drawing the conclusion that there is a biofilm present? Even if the wound has been stuck in the inflammatory phase for an extended period of time?

A: I believe if a wound has not progressed in healing or actually worsened with good standard wound care, I would assume biofilms are present on the wound and are contributing to the failure of the wound to heal. I would treat aggressively with debridement and Cadexomer Iodine dressings, then when the wound exudates decreases or the wound begins to improve, shift to topical or systemic antibiotics.

Q: Can regular debridement be achieved with an appropriate interactive dressing, eg Iodoflex™ that assists with debridement?

A: In general we would advocate using episodic debridement, as we studied in this group. The Iodoflex™ that you mention is the same Cadexomer Iodine that we studied. At present there are no data to support that autolytic debridement or that enzymatic debridement disrupts biofilm in vivo, although this is being investigated.

Q: How often did you change the dressing on the diabetic foot ulcers?

A: In this study they were changed an average of eight times per week. This would not be our usual protocol with this product.

Q: Cadexomer continues to kill up to three days. Why were the dressings changes daily or every two days in this study?

A: In this study many of the patients were caring for themselves and therefore showered/bathed daily. Therefore, they changed their dressings daily. We would allow for every 48-72 hour dressing changes.